

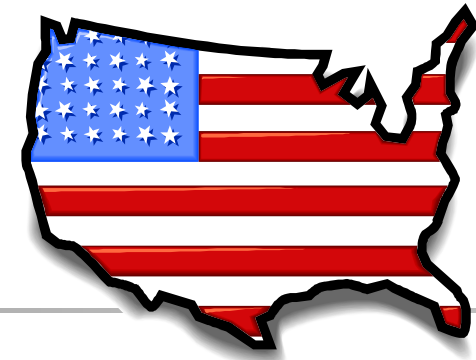
Gas Quality Harmonisation Lessons from the USA

EC Workshop on Gas Quality - December 5, 2011 Brussels



WWW.EUROMOT.EU

Short History



Less than a decade ago, the USA had big plans for LNG imports:

- Security of energy supply
- Relatively low greenhouse gas emissions



Until then: close to constant gas composition

Concern: LNG imports might disturb the quality of gas

FERC (Federal Energy Regulating Committee) approached:
Natural Gas Council & other interested parties on how to deal
with the problem:

New committee NGC+

Result: White paper on Natural Gas Interchangeability and
Non-Combustion End Use, February 28, 2005

NGC+

Many parties involved

Association, Chair
Mark Hereth, PPIC
Facilitator
LNG Suppliers
Edgar Kulpers, Shell
Mike Milling, Chevron/Tosco
Lee Benburg, Sempra
Ben Ho, BP
Mark Bentley, ExxonMobil
Pat Outtrim, Cheniere
Ed Ludobsky, Cheniere
Phil Seeding, 40 North
America
Hubert Loussouarn, Total
Frank Katsiak, Tractebel
John H. Ido, Shell
Randy Mills, Chevron/Tosco
Al Falica, BP
Rudy Adamski, Tractebel
Greg Bartholomew, Sempra
Pipelines
Terry Ross, Interstate
Natural Gas Association of
America
Grant McCracken, Panhandle
Energy
Todd Bauman, Questar
Hank Podlitzitz, B. Paso
Dennis Allen, Cross
Country Energy
Scott Zieren, El Paso
Regi George, El Paso
Ian Morris, Cross Country
Energy
Tham Phan, Duke Energy
Jeryl Mohr, Panhandle
Energy
David Nass, Dominion
Energy
Bruce Hedman, Energy and
Environmental Analysis
Utilities (EOC) and Income
Incentives Power, General
Robert Wilson, Koyan Energy
Larry Saunders, Southern
California Gas Company
Roxanne Nichols, Xcel Energy
Peter Collette, Public Service
Electric and Gas
John Erickson, American Public
Gas Association
Keith Shaw, Southern California
Gas Company
Lee Stewart, Southern California
Gas Company
Joe Bonner, Pacific Gas and
Electric
Mark Galsamp, Louisville Gas and
Electric
Robert Thumrow, Peoples Gas
Glen Schwallbach, Wisconsin
Public Service
Michael Gerdies, BSH
Michael Farmer, Peoples Gas
Pierluigi Quattrone, Edison
Robert Kemper, Southern
California Gas Company
Frank Struss, Consolidated
Edison
Al Quatrone, American Gas
Association
Steven Zavadnick, Baltimore Gas
and Electric
Lori Trawick, American Gas
Association
Ed Anderson, R.R. Rudden
Regis Klingler, CMS Energy
Jack Zeng, Public Service
Electric and Gas
Richard Rudden, R. R. Rudden and
Associates
Joseph Sertaro, Niagara Mohawk
White Paper on Natural Gas Interchangeability
And Non-Combustion End Use
32
Power Generation
Chuck Underman, Edison
Electric Institute
Jack Cashin, Electric Power
Supply Association
Bruce Rung, Siemens
Craig Chancellor, Calpine
Colin Wilkes, General
Electric Power Generation
Keith Barnett, American
Electric Power
Dona Gussow, Florida
Power and Light
Mike Stassen, Combustion
Science & Engineering, Inc.
Richard Riley, Combustion
Science & Engineering, Inc.
Nicola Fudencio, Calpine
Jim Downs, Calpine
Feedstock
Tom Carville, The Fertilizer
Institute
George Valadez, Alcoa
Dana Wiggins, Process Gas
Consumers
Dave Chaffee, Bloom Engineering
(for Alcoa)
Kristen Gibbs, Process Gas
Consumers
Appliances
Mark Kendall, Gas Appliance
Manufacturers Association
Frank Samonik, Gas Appliance
Manufacturers Association
Richard Oripes, Association of
Home Appliance Manufacturers
Jack Goldstein, Hearth, Patio and
Barbecue Association
Research
David Ruz, GTI
State Official
Eric Olson, State of Utah
Gas Processing
Mark Sutton, Gas Processors
Association

- 15 LNG suppliers
- 12 pipeline companies
- 24 gas selling utilities
- 11 power producing companies
- 5 feedstock companies
- 4 appliance manufacturer representatives

19 meetings and conference calls

Aspects:

- Combustion efficiency
- Emissions
- Flame stability
- Performance

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Preliminary NGC+ Results

Index	Maximum Value
Wobbe Index	52.2 MJ/m ³
Higher heating value	41.0 MJ/m ³
C4+ gases	1.5 mol %
Inert components	4%

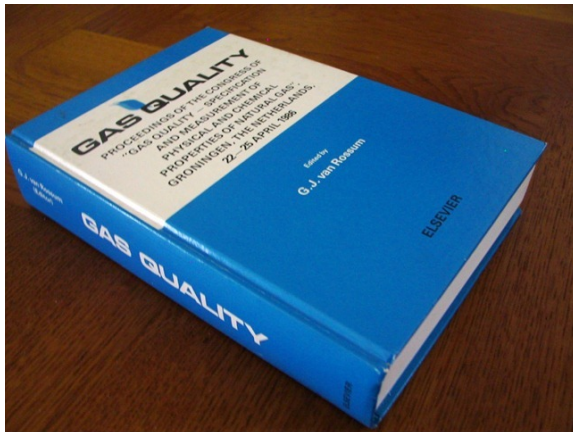
Wobbe range limit: +/- 4% around the traditional average

However, max 4% inerts means:

- Minimum Wobbe cannot be lower than 49.6 MJ/m³
- Higher heating value cannot be lower than 38.2 MJ/m³

Therefore : Actual Wobbe range: +/- 2.5% around the average.

Gas Quality is a 'Technological Science'



749 pages with gas quality papers is just a very small sample of relevant data

Gas quality is not:

- **An opinion**
- **A political decision**
- **A commercial slogan**

Before the EU liberalisation, every major gas company had a large gas-application research department e.g. Ruhrgas, British Gas, Gasunie, SNAM

Key Note by Gas Expert Prof. G.F. I Roberts



*'Gas supplier is responsible for best quality, because:
Gas customer cannot:*

- Assess gas quality;*
- Return gas if unsatisfactory'.*

*'Gas will increasingly be used for electricity production
and transport (engines, turbines) and less in households'*

*'A wide gas composition range automatically lowers
efficiency and increases emissions'*

*'Gas quality should be user led, not supplier led and be
careful not to become politician led'*

Next keynote by G.F. Steinmetz, Baltimore Gas & Electric



'Pipeline Quality might be a misnomer; appliance quality would be more appropriate'

'Gases must be compatible with the equipment and the appliances in use'

'General recognition is given to the inadequacy of Heating Value, Specific Gravity and Wobbe Number to gauge interchangeability. The BURNING CHARACTERISTICS of the various component gases must be considered'

Shale gas: Experience with the NGC+ rules

Shale gas can contain a large amount of higher hydrocarbons and cannot meet the NGC+ specs.

Therefore: Strippers in the USA to remove the higher hydrocarbons ('Natural Gas Liquids – NGLs')

Valerie Wood in Pipeline & Gas Journal September 2011:



*'NGLs are priced in accordance with crude oil prices.
[...] the production of high-value NGLs helps to lower
natural gas break-even prices'*

In the USA, gas producers, 'appliance' manufacturers and customers are happy with the NGC+ range

Anticipated general problems with a wide gas composition range

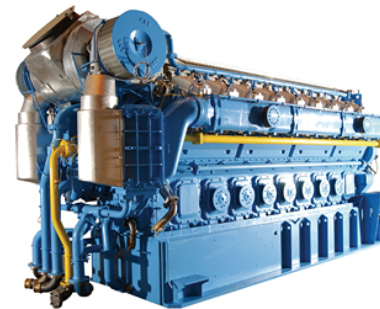
Burners:

- flash back
- blow off/flame lift
- yellow tipping
- incomplete combustion
- higher emissions
- lower efficiency



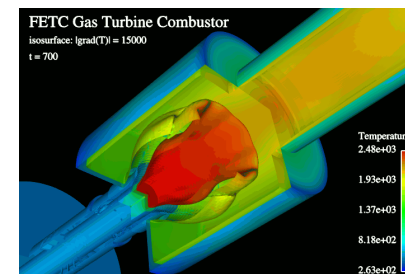
Gas Engines:

- knocking
- reduced efficiency
- tripping
- combustion instability
- reduced output
- higher emissions



Gas Turbines:

- tripping
- combustion instability
- higher emissions
- increased wear
- reduced efficiency



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The EASEE-gas specs:

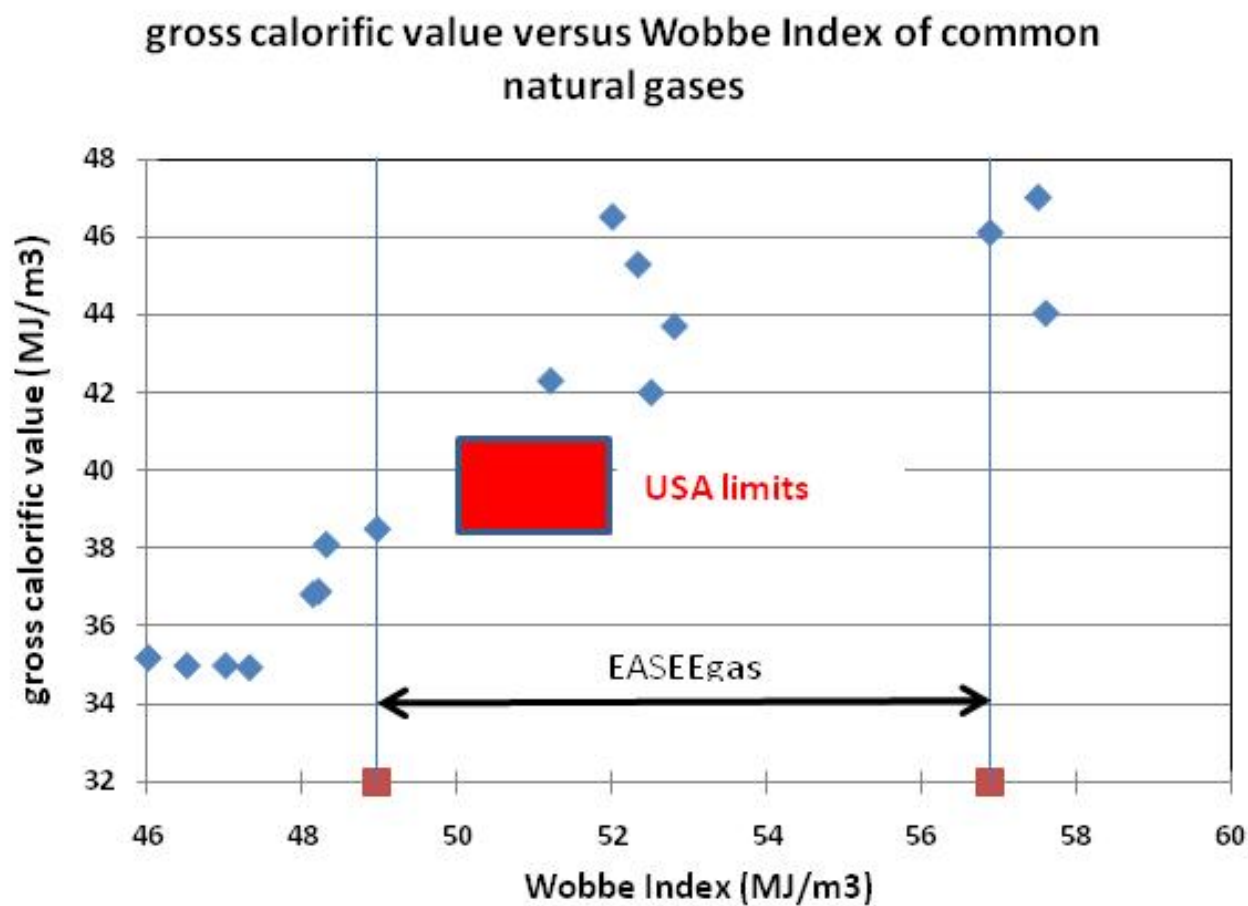
Nothing about flame speed, ignitability, knock resistance, speed of composition change (plug flow)

Parameter	Unit	Min	Max	Recommended implementation date
WI	kWh/m ³	[13.60]	15.81	1/10/2010
d	m ³ /m ³	0.555	0.700	1/10/2010
Total S	mg/m ³	-	30	1/10/2006
H ₂ S + COS (as S)	mg/m ³	-	5	1/10/2006
RSH (as S)	mg/m ³	-	6	1/10/2006
O ₂	mol %	-	[0.01]*	1/10/2010
CO ₂	mol %	-	2.5	1/10/2006
H ₂ O DP	°C at 70 bar (a)	-	- 8	See note **
HC DP	°C at 1 – 70 bar (a)	-	- 2	1/10/2006

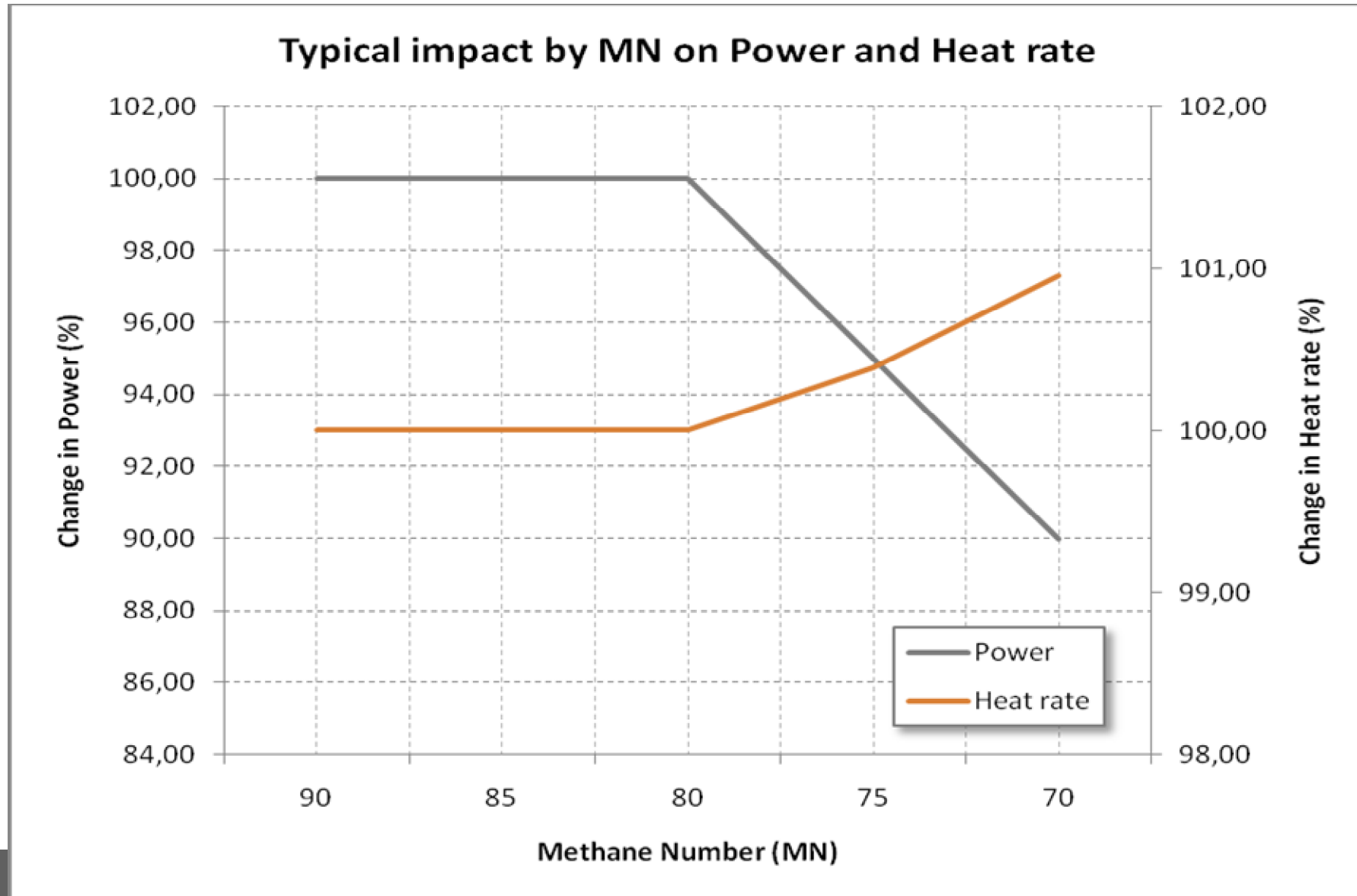
* EASEE-gas has organised an oxygen measurement survey, which by end of 2005 will examine the maximum feasible limit equal to or at an alternative specified value below 0.01 mol %.

** At certain cross border points, less stringent values are used than defined in this CBP. For these cross border points, these values can be maintained and the relevant producers, shippers and transporters should examine together how the CBP value can be met in the long run. At all other cross border points, this value can be adopted by 1 October 2006.

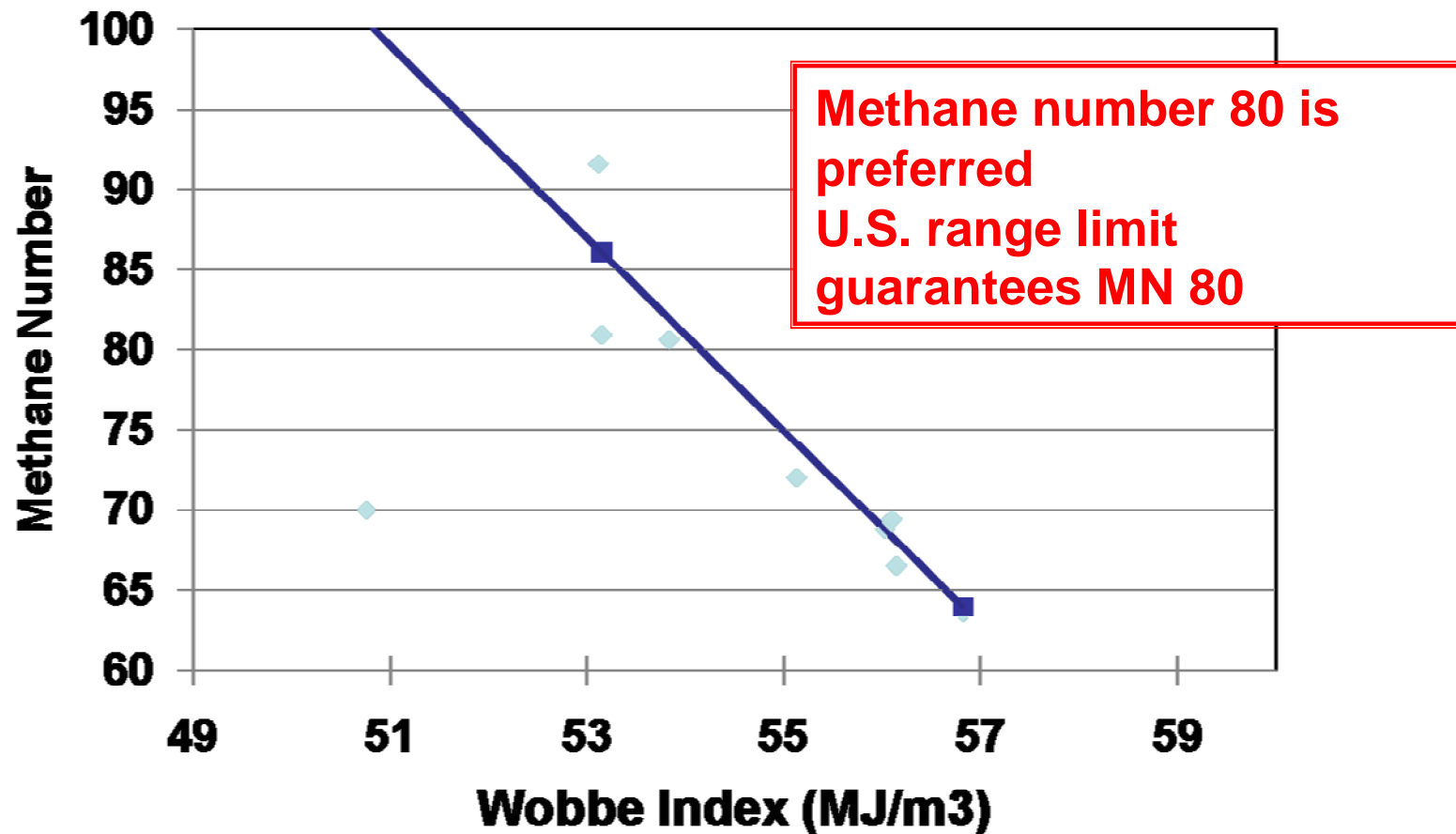
USA Consensus versus unilateral EU range



Effect Methane Number/Knock Resistance on Performance



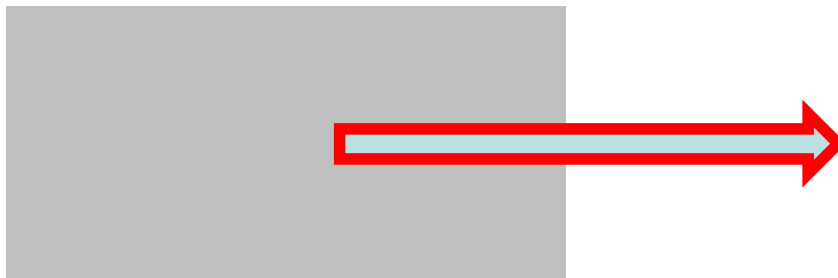
Knock resistance for the EASEE-gas range



PLUG flow

Quality 2

Quality 1



Even if gas-fuelled appliances have been equipped with expensive feedback and control equipment, accepting plug flow is close to impossible

The EASEE-gas specs do not show any limitations in plug flow.

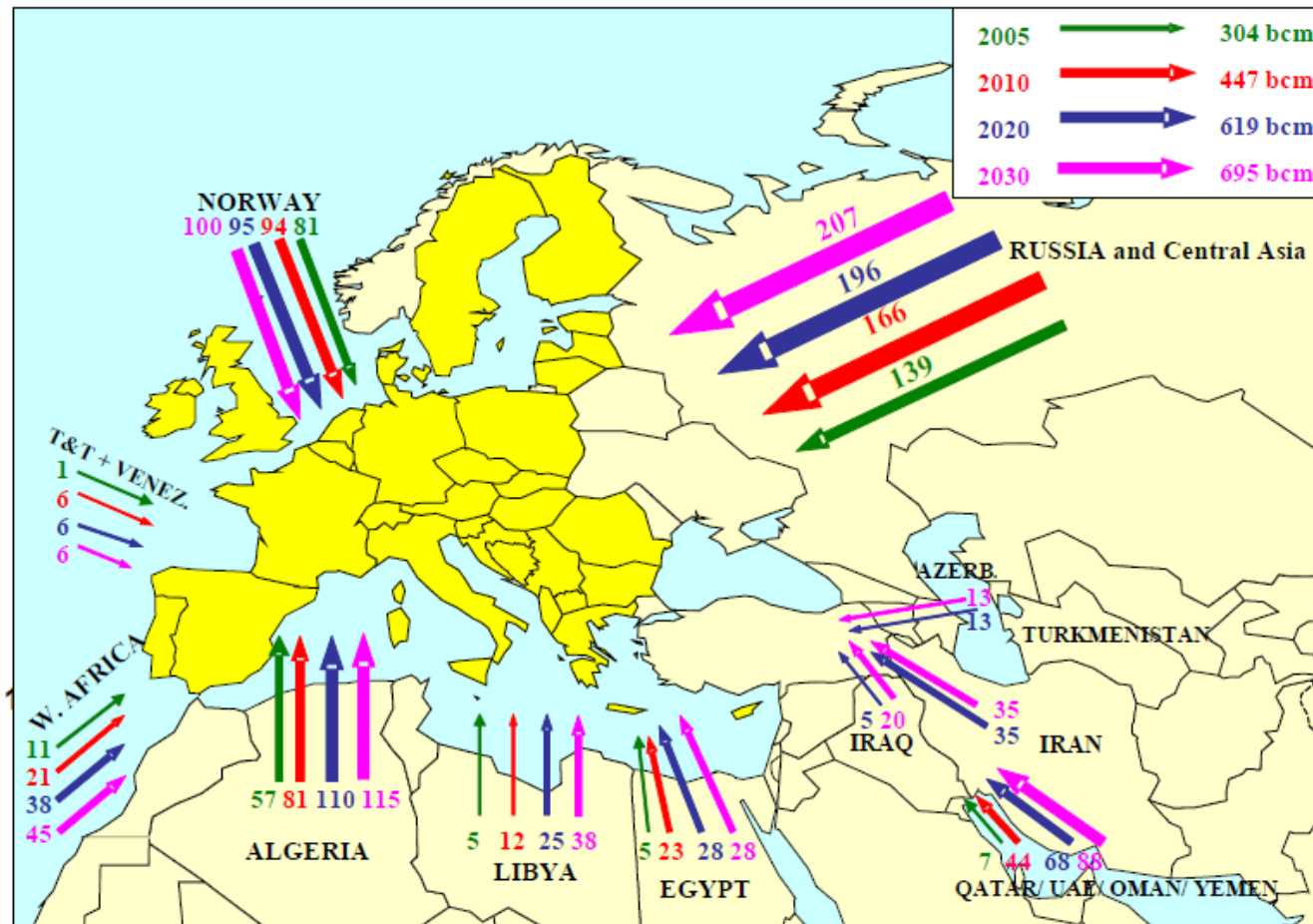
Energy delivery measurement problem

A gas meter measures
volume flow

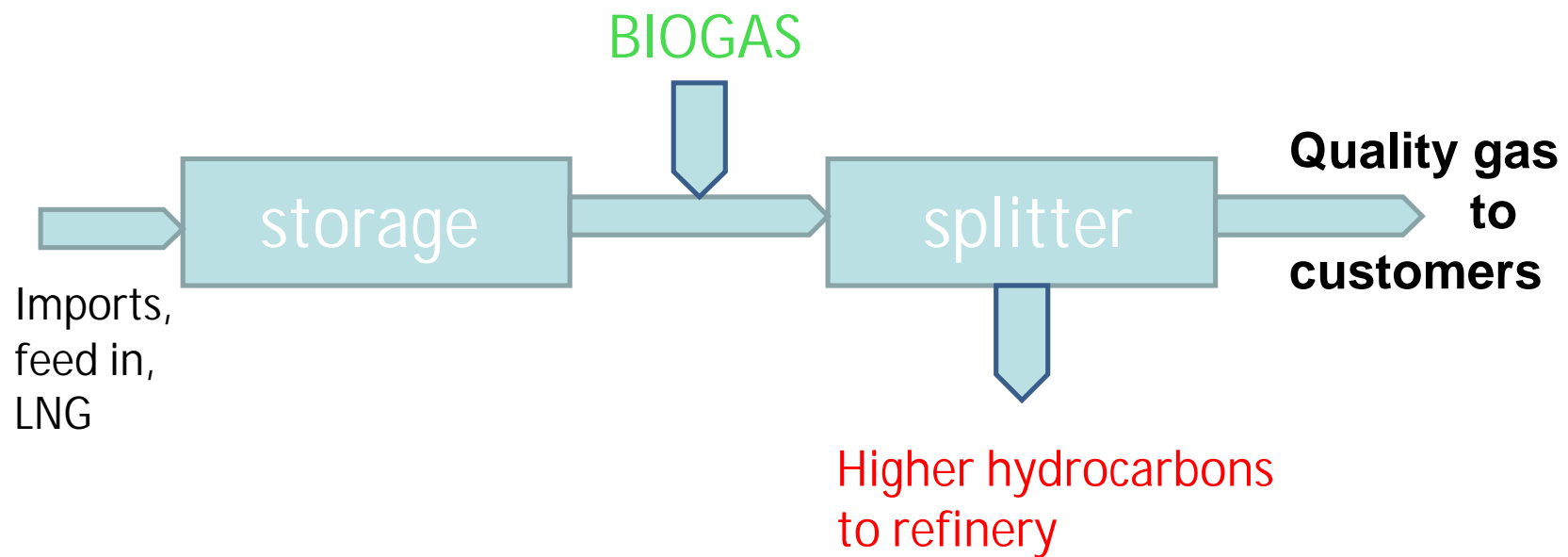


The upper calorific value in the EASEE-gas specs
can vary between 36 MJ/m³ and 48 MJ/m³:
Huge errors in energy delivery measurement

Poor Europe: minor 'security' gas flows reduce the gas quality substantially



Optimum solution for max. flexibility & best economy



EUROMOT Proposal for gas specifications (marked red)

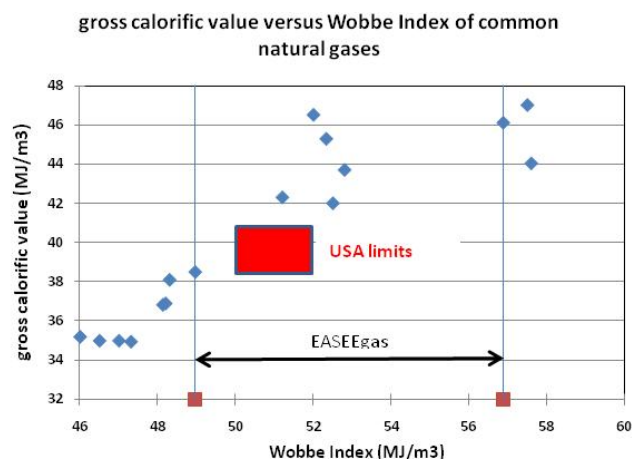
Wobbe Index	kWh/m ³	13.6	15.81	Maximum variation +-2% & providing MN of 80-100
Methane Number		80	100	EASEE CBP gives MN 48 - 102
Ignitability	Lambda range		2.2	
Laminar Combustion velocity	cm / s	28	32	
Relative density	m ³ /m ³	0.55	0.700	Ensuring the right Wobbe range
O ₂	mol %	-	0.01	
S	mg/m ³	-	5	Introducing Oxi-cat for reducing Form-Aldehyde restricts the S content of the gas

EUROMOT Proposal for gas specifications (marked red)

H ₂ S +COS (as S)	mg/m ³	-	5	
RSH (as S)	mg/m ³	-	0	Preferably no S in odorant
CO ₂	mol %	-	2.5	
H ₂ O DP	°C at 70 bar	-	- 8	
HC DP	°C at 1- 70 bar	-	< - 10	To avoid condensation in cooler stretches of gas pipelines
Supply pressure	Bar (gauge pressure)	8	-	Many applications (e.g. engines or turbines) need a higher pressure than domestic applications

EUROMOT on the GL Noble Denton Draft Report

- An excellent study by experts with extensive knowledge about the use of gas (ex BG Loughborough);
- The results are very clear: a wide gas range is way too expensive and lowers performance;
- Experience in the USA fully supports the conclusions of the GL Noble Denton report.



Conclusion

- The EASEE-gas specs are too broad.
- A wide gas composition range lowers efficiency and increases emissions
- Faced with similar issues as the EU, the U.S. has already reached a consensus following a broad-based stakeholder consultation:
 - The resulting NGC+ gas specifications advocate higher gas quality and narrower ranges for key gas quality parameters than EASEE-gas specs.
 - Gas components which make that the gas do not meet the NGC+ specifications are split off and sold (e.g. Natural Gas Liquids are sold to refineries)
- Split off Natural Gas Liquids are priced in accordance with crude oil prices. The production of high-value NGLs helps to lower natural gas break-even prices

2011

YEARS
Promoting Engine in Society

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